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Claims:

- 1 1. A process for selectively extracting metal values from a starting material which
2 includes one or more solubilizable metal values, the process comprising:
3 separating and removing fluorine values from the starting material;
4 leaching the remaining material to solubilize metal values contained in the
5 remaining material and generate an aqueous solution comprising said solubilized
6 metal values; and
7 extracting a solubilized metal value from said aqueous solution.
- 1 2. The process of claim 1 wherein the step of separating and removing fluorine
2 values comprises:
3 reacting the starting material with a solution of a mineral acid for a period
4 of time, and under temperature and pressure conditions sufficient to solubilize at
5 least a portion of tantalum and niobium from the starting material;
6 separating and drying the undissolved material;
7 reacting the undissolved material with mineral acid comprising sulfuric acid
8 for a period of time, and under temperature and pressure conditions sufficient to
9 liberate hydrogen fluoride gas and to generate a sulfated material.
- 1 3. The process of claim 2 wherein the step of leaching the undissolved material to
2 solubilize metal values contained in the undissolved material and generate an
3 aqueous solution comprising said solubilized metal values comprises:
4 reacting the sulfated material with water for a period of time, and under
5 temperature and pressure conditions sufficient to generate said aqueous solution
6 comprising solubilized metal values;
7 filtering said aqueous solution to separate remaining material solids from
8 said aqueous solution.
- 1 4. The process of claim 3 wherein the aqueous solution includes zirconium and
2 uranium and the step of extracting a solubilized metal value from said aqueous
3 solution comprises extracting zirconium and uranium metal values by a process
4 comprising:
5 contacting said aqueous solution with an organic medium which includes a
6 diluent and an extractant, said diluent being immiscible with said aqueous solution
7 thereby producing an organic phase comprising zirconium and uranium and an
8 aqueous raffinate phase;
9 separating said organic phase from said raffinate phase;
10 stripping zirconium from said organic phase by contacting said organic

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11 phase with a zirconium stripping agent, the zirconium stripping forming an
12 aqueous phase comprising zirconium and a resultant organic phase comprising
13 uranium; and

14 stripping uranium from said resultant organic phase by contacting said
15 resultant organic phase with a uranium stripping agent, the uranium stripping
16 forming an aqueous phase comprising uranium and a final organic phase
17 comprising said diluent and said extractant.

1 5. The process of claim 4 wherein the aqueous solution includes uranium,
2 zirconium, thorium and scandium and the process further comprises extracting
3 thorium and scandium metal values from said raffinate formed by said contact
4 between said aqueous solution and said organic medium, by a process comprising:
5 contacting said raffinate with another organic medium which includes a
6 diluent and an extractant, said diluent being immiscible with said aqueous solution,
7 thereby producing an organic phase comprising thorium and scandium and an
8 another aqueous raffinate phase;

9 separating said organic phase from said another raffinate phase;
10 stripping thorium from said organic phase by contacting said organic phase
11 with a thorium stripping agent, said thorium stripping forming an aqueous phase
12 comprising thorium and a resultant organic phase comprising scandium; and
13 stripping scandium from said resultant organic phase by contacting said
14 resultant organic phase with a scandium stripping agent, said scandium stripping
15 forming a phase comprising scandium from said resultant organic phase and an
16 aqueous phase comprising said scandium stripping agent and a final organic
17 phase.

1 6. The process of claim 4 wherein said organic medium further comprises a
2 modifier.

1 7. The process of claim 5 wherein said another organic medium further comprises
2 a modifier.

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1 8. A process for selectively extracting zirconium, uranium, thorium and scandium
2 metal values from a starting material which includes the metal values comprising:
3 reacting a starting material with a solution of a mineral acid for a period of
4 time, and under temperature and pressure conditions sufficient to solubilize
5 tantalum and niobium into solution and thereby generate a solution comprising
6 tantalum and niobium, and a remaining material;

7 separating and drying the remaining material;
 8 reacting the remaining material with mineral acid for a period of time, and
 9 under temperature and pressure conditions sufficient to liberate hydrogen fluoride
 10 gas and to generate a sulfated material;
 11 reacting (leaching) the sulfated material with water for a period of time, and
 12 under temperature and pressure conditions sufficient to generate an aqueous
 13 solution of the metal values;
 14 filtering said aqueous solution to separate remaining material solids from
 15 the aqueous solution;
 16 contacting said aqueous solution with an organic medium which includes a
 17 diluent and an extractant, and preferably further includes a modifier, said diluent
 18 being immiscible with said aqueous solution thereby producing an organic phase
 19 comprising zirconium and uranium and an aqueous raffinate phase depleted in
 20 zirconium and uranium;
 21 separating said organic phase from said raffinate phase;
 22 stripping zirconium from said organic phase by contacting said organic
 23 phase with a zirconium stripping agent, said stripping forming a zirconium
 24 aqueous phase comprising zirconium from said organic phase and a resultant
 25 organic phase comprising uranium, said diluent and said extractant; and
 26 stripping uranium from said resultant organic phase by contacting said
 27 resultant organic phase with a uranium stripping agent, said stripping forming a
 28 uranium aqueous phase comprising uranium from said resultant organic phase and
 29 a final organic phase comprising said diluent and said extractant.
 30 contacting said raffinate with another organic medium which includes a
 31 diluent and an extractant, and preferably further includes a modifier, said diluent
 32 being immiscible with said raffinate, thereby producing an organic phase
 33 comprising thorium and scandium and an another raffinate phase depleted in
 34 thorium and scandium;
 35 separating said organic phase from said raffinate phase;
 36 stripping thorium from said organic phase by contacting said organic phase
 37 with a thorium stripping agent, said stripping forming a thorium aqueous phase
 38 comprising thorium from said organic phase and another resultant organic phase
 39 comprising scandium, said diluent and said extractant; and
 40 stripping scandium from said another resultant organic phase by contacting
 41 said resultant organic phase with a scandium stripping agent, said stripping
 42 forming a scandium phase comprising scandium from said resultant organic phase,
 43 an aqueous phase comprising said scandium stripping agent and another final
 44 organic phase comprising said diluent and said extractant.

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9. A process for selectively extracting zirconium, uranium, thorium and scandium

2 metal values from a sulfated starting material which includes the metal values

3 comprising:

4 reacting (leaching) the starting sulfated material with water for a period of

5 time, and under temperature and pressure conditions sufficient to generate an

6 aqueous solution of the metal values;

7 filtering said aqueous solution to separate remaining material solids from

8 the aqueous solution;

9 contacting said aqueous solution with an organic medium which includes a

10 diluent and an extractant, and preferably further includes a modifier, said diluent

11 being immiscible with said aqueous solution thereby producing an organic phase

12 comprising zirconium and uranium and an aqueous raffinate phase depleted in

13 zirconium and uranium;

14 separating said organic phase from said raffinate phase;

15 stripping zirconium from said organic phase by contacting said organic

16 phase with a zirconium stripping agent, said stripping forming a zirconium

17 aqueous phase comprising zirconium from said organic phase and a resultant

18 organic phase comprising uranium, said diluent and said extractant; and

19 stripping uranium from said resultant organic phase by contacting said

20 resultant organic phase with a uranium stripping agent, said stripping forming a

21 uranium aqueous phase comprising uranium from said resultant organic phase and

22 a final organic phase comprising said diluent and said extractant.

23 contacting said raffinate with another organic medium which includes a

24 diluent and an extractant, and preferably further includes a modifier, said diluent

25 being immiscible with said raffinate, thereby producing an organic phase

26 comprising thorium and scandium and another raffinate phase depleted in

27 thorium and scandium;

28 separating said organic phase from said raffinate phase;

29 stripping thorium from said organic phase by contacting said organic phase

30 with a thorium stripping agent, said stripping forming a thorium aqueous phase

31 comprising thorium from said organic phase and another resultant organic phase

32 comprising scandium, said diluent and said extractant; and

33 stripping scandium from said another resultant organic phase by contacting

34 said resultant organic phase with a scandium stripping agent, said stripping

35 forming a scandium phase comprising scandium from said resultant organic phase,

36 an aqueous phase comprising said scandium stripping agent and another final

37 organic phase comprising said diluent and said extractant.

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